Childhood & Growth

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CHILDHOOD AND GROWTH

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A PAPER READ OCTOBER 6TH, 1905, BEFORE THE NEW HAVEN MOTHERS' CLUB

BY

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WITH AN INTRODUCTION

BY

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Editor's Preface

IN searching for physiological wisdom relative to the growth and care of children, I was greatly interested in securing this paper, which Professor Lafayette B. Mendel of the Sheffield Scientific School of Yale University prepared for and read before the Mothers' Club of New Haven, Connecticut, in October last.

It is by an eminently careful physiologist whose specialty tends towards the chemical side of the science, and who is unprejudiced either by parentage or tradition in his estimate of the subject of Childhood and Growth.

No other introduction is necessary to a presentation so clear and fascinating as this is.

I have begged the privilege of presenting this charming essay to the public in its present form.

HORACE FLETCHER.

CHILDHOOD AND GROWTH

Childhood and Growth

THE problems which confront the mothers of young children are essentially physiological in character. The infant enters the world in an extremely helpless condition, without adequate control of its muscles and with most imperfect organs of sense. It is deprived of the assistance and experience which we derive from these important groups of organs in our contact with the things about us. Aside from what is acquired through the senses of taste and of smell, a long period intervenes until the child obtains any adequate impressions of its

environment or any appropriate and helpful appreciation of the relation which it sustains to its surroundings. The good and the bad, the harmful or the harmless, fail to be recognized; or if they are indeed appreciated, the power of expressing approval or disapproval is either lacking or else manifested by signs which we are unable to interpret correctly without the greatest difficulty. Speech is still wanting at this early age, and the child lacks such instincts as might guide it to do without parental care; accordingly, observation and unceasing attention must supply that which nature has not yet provided. Thus does the mother — the caretaker, the

nurse — become responsible for the welfare of the infant.

I have recalled these facts, so familiar to each of you, in order to emphasize at the outset the pre-eminent importance of physical factors in early childhood. In a recent paper Dr. Elizabeth Campbell wrote:

> "A young expectant mother is full of vagaries; she tries to think along certain lines, such as poetry, music, or art, in order that her child may be a poet, musician, or artist; she often becomes a prey to quackeries of all kinds. . . . A very few straightforward talks to dissipate her vagaries and fears, injunctions to lead a natural exist-

ence, turning her attention to the fascinating study of child life and its limitless possibilities, teaching her constantly that she must be ready to begin the training of her child at once by submitting, with understanding, to the regulations imposed, will secure a rhythmical habit which will ripen into happy obedience." [1]

Mothers as individuals, and associations of mothers, are ever prone to discuss the problems which especially concern the mind and the soul of the child. My remarks aim to present some quite different aspects of growth in childhood which seem to me worthy of more careful and intelligent con-

[1] "New York Medical Journal," 1905, p. 581.

sideration than is usually accorded to them.

The care of the young in early infancy is by no means a simple task; for it involves a period of profound physiological changes which may be of momentous significance in the later life of the individual. The characteristic function of the body in childhood is *growth* — essentially a physiological change, into the characteristics of which we must inquire more closely.

The physiologist is accustomed to think of the animal body as a machine. Just as an engine transforms the energy appropriated in the form of fuel into useful work and heat, so

the body mechanism converts the energy of its fuel — the food we eat — into muscular activity and body warmth. In the case of the adult the analogy is in many ways a far-reaching one. The food supply must be adapted to the needs of the body for activity, movement, and warmth. Work calls for more nutriment than does inactivity. When the diet is superabundant, we may store it up and put on flesh ; or if it is inadequate, we may burn up our own tissues to supply the deficiency, and experience a loss of body weight. The demands of the body for appropriate and adequate fuel are satisfied by correct nutrition, under which process is in-

cluded the proper preparation of the foodstuffs for utilization — in other words, digestion — as well as the subsequent elimination of the waste products, — that is, the function of excretion. There are, obviously, incidents of wear and tear in our machinery which must be made good by the nutritive processes. Such losses in the adult assume no significant proportions. In the young, however, the additional process of *growth* must be provided for; and nutrition here plays a novel rôle in supplying the material for the building up of new tissue, besides making provision for the energy devoted to muscular activity and warmth.

The relatively large demands of children for nutriment, especially at the periods of most active development, no longer surprise us when we recall that the food materials are required for *growth* in addition to the maintenance of the ordinary body functions. But I believe that the popular impression regarding the *proportion* of the food intake of children devoted to purposes of growth is greatly exaggerated. A boy of fifteen, — at a period of very vigorous growth, — for example, will consume about 1800 grams (solids and liquids) per day, with an average increase of only 20 grams in body weight; similarly, a girl of thirteen years consum-

ing 1500 grams daily will add an average of 12 grams only to her weight each day. The portion of the substance actually stored up each day — scarcely more than $\frac{1}{100}$ of the intake — is quite small in itself and cannot be the immediate cause of the large demand for food and drink. On the contrary, the growing child excretes the greater part of its ingested nutrients in the form of waste products. The nutritive demands are large because all of the chemical activities of the body are heightened at this age. The intensification of the nutritive exchanges in the young is an interesting fact, although its causes are still obscure.

Every proud mother — and I presume that all mothers are instinctively proud of their children — is familiar with the average absolute gains of infants in body weight. Thus an average baby will gain about an ounce a day during the first month, and continue to add flesh. The *relative* daily rate of growth, however, is quite different at varying periods. In terms of the total weight of the child, it changes approximately as follows:

[1] THE RELATIVE DAILY GAIN OF CHILDREN

In the first month it is about .	1.00%	of the body weight
At the middle of the first year	0.3 %	" " "
At the end of first year . .	0.15%	" " "
At the fifth year	0.03%	" " "

[1] The figures are taken from Camerer.

Increasing to a Maximum of

In boys	0.07% of the body weight
In girls	0.04% " " "

* * * * *

In the *calf* the corresponding figure for the first week is .	5% of the body weight

I desire to point out that in animals the relative rate of growth is usually much larger than that of children, amounting, as noted above in the case of the calf, for example, to as much as 5 per cent. The significance of this will be referred to later.

With the pre-eminent importance of the nutritive processes for the growing child duly impressed upon us, we naturally stop to inquire what is the equipment of the young body for the physiological work it has to

do. Here too, at early ages, we find different "degrees of readiness" in different animal species in regard to their ability to perform the functions peculiar to the fully developed individual. In a general way this is illustrated by the varying ability to get along — to obtain and prepare food independently of the parent. Frequently adequate digestive powers are not matured at birth, and more often the heat-regulating mechanism is imperfectly developed at this stage. Such deficiencies are present in those animals, like birds, which hatch from the egg and have an extra-uterine development, as well as in those which attain growth in closer relation

to the mother. This "unpreparedness" of the newly born for an independent existence is interestingly exemplified in the inability of the young child, as well as the chick or the mouse or the kitten, to maintain its body temperature perfectly. You are quite familiar with the fact that owing to the peculiar nervous regulating mechanism with which the organism is endowed the body temperature of an adult is remarkably constant despite varying external conditions. Any marked deviation from the so-called normal temperature of man constitutes a familiar symptom of disease. When newly born puppies, kittens, and

rabbits are removed from their usual warm surroundings, their temperature will become lowered and continue to fall until it reaches a point a few degrees above the temperature of the surrounding air. These animals are blind at birth, helpless, and in some cases naked; and they cannot maintain their temperature without the protective warmth and instinctive huddling together afforded by the mother. In contrast with such animals are newly born guinea-pigs. They come into the world in a condition of marked development; the animals are active, their eyes are open, they have a partial coat of fur, and can be largely independent of the

mother in procuring food. From the earliest period these animals can maintain a fairly constant temperature amid colder surroundings. In human infants the conditions correspond with those pertaining in young animals of the more dependent class rather than those born in an advanced condition of development. The infantile temperature is variable, owing to the imperfect development of the regulating power, notably in immature young individuals. The readiness with which the temperature irregularities manifest themselves upon slight provocation, even in children of several years' growth, is familiar to every observing mother.

It remains for us, therefore, to draw the proper lesson from this defenceless condition of the young amid their colder environment. We learn to appreciate what warm clothing means to the naked infant otherwise helpless in its resistance to the atmosphere about it. I am ready to believe that not a little abdominal pain and crying among infants is ultimately attributable to the thoughtless exposure of arms and legs, even in summer months. The misguided judgment or unconcealed convenience of mothers occasionally permits children to cry until they are hoarse. This is neither health-giving nor humane; and the smallest attention to the

details just discussed will frequently restore a restful quiet. The invigorating thrill which cold in the form of a cold bath or a cold sleeping-room arouses in an adult is scarcely attained at those ages where the temperature-regulating mechanism is not yet thoroughly developed for the appropriate response of heat production. And therefore I am inclined to believe that the prevalent practice — shall I call it a fad? — of dressing young boys and girls in short socks at certain seasons is inadvisable, if not actually barbarous. Man has instinctively protected himself against the unpleasantness of a cold environment by the adoption of clothing.

The extent of this protection is varied with the climate in which he resides. In our average climate about 80 per cent of the body is ordinarily clothed. The bared-leg costumes of the present mode may leave as much as 30 per cent to 40 per cent of the child's body surface exposed with correspondingly increased loss of heat. Some of us have noticed that even in adults the kiltie suit may become uncomfortably cool on a New Haven summer day! What shall we expect in the less resistant child during cool autumn weather?

Turning again to the question of nutrition, I may remind you that the child, like the adult, requires the

three typical groups of foodstuffs: the *proteids* (such as the casein of milk, the white of egg, or the substance of meat) to build the tissues; *carbohydrate* foods (like the sugars and starches) and *fats* to furnish energy. The relative proportions in which they ordinarily participate in the diet is indicated below:

PROPORTION OF THE ENERGY INTAKE CONTRIBUTED BY THE DIFFERENT GROUPS OF NUTRIENTS IN INFANCY

Proteids	19%
Carbohydrates	28%
Fats	53%
	100%

Eggs and milk are ideal foods in the sense that they contain practically *all* of the food elements es-

sential to the young whose growth they are intended to support. But nature has done even more; she has adapted the milk of every species to the special needs of its young, as has been admirably demonstrated by Professor Bunge.

In the table below it will be noted that the richness of milk in proteid, inorganic salts, lime and phosphoric acid — substances needed to build the tissues and bony skeleton — is proportioned to the rate of growth. Thus the food supply of the rapidly developing puppy is comparatively more abundant in the necessary constituents than is the milk furnished to the slowly growing infant.

Species	Time in which the body weight of the newly born animals is doubled	One Hundred Parts of Milk Contain			
		Proteid	Mineral Matter	Lime	Phosphoric Acid
Man . . .	180 days	1.6	0.2	0.32	0.47
Horse . .	60 "	2.0	0.4	1.24	1.31
Cow . . .	47 "	3.5	0.7	1.60	1.97
Goat . . .	19 "	4.3	0.8	2.10	3.22
Pig . . .	18 "	5.9	. .	. . .	. . .
Sheep . .	10 "	6.5	0.9	2.72	4.12
Dog . . .	8 "	7.1	1.3	4.53	4.93
Cat . . .	7 "	9.5	. .	. . .	. . .

It is a further remarkable fact that the proportion of the various inorganic substances (the salts or mineral nutrients as they are sometimes called) to each other in milk is almost the same as it is in the entire body of the animals which thrive upon it.

The relative demands of the growing organism for more lime than magnesium, more phosphorus than iron, etc., is thus provided for.

MINERAL CONSTITUENTS OF ONE HUNDRED PARTS OF

	SUCKING PUPPY	DOG'S MILK	DOG'S BLOOD
Potassium, K_2O . .	8.5	10.7	3.1
Sodium, Na_2O . . .	8.2	6.1	45.6
Calcium, CaO . . .	35.8	34.4	0.9
Magnesium, MgO. .	1.6	1.5	0.4
Iron, Fe_2O_3	0.34	0.14	9.4
Phosphorus, P_2O_5 . .	39.8	37.5	13.3
Chlorine, Cl	7.3	12.5	35.6

These small quantities of the inorganic constituents of milk, insignificant though they seem, are yet most potent in their influence upon growth and nutrition. Every one recognizes

the need of iron for the blood, of lime for the bones; but too often the importance of the others is overlooked. Thus, without common salt (chloride of sodium) no normal gastric juice can be formed.

In the table following, the figures for the composition of the milk of several animal species of domestic importance are placed together for comparison.

COMPOSITION OF THE MILK OF VARIOUS SPECIES
(Percentages)

	WOMAN	COW	GOAT	MARE	ASS	PIG
Total Proteids	1.7	3.5	4.3	2.0	2.2	5.9
Fat . . .	3.4	3.7	4.8	1.2	1.6	6.9
Sugar . . .	6.1	4.9	4.5	5.7	6.0	3.8
Mineral Matter	0.2	0.7	0.8	0.4	0.5	1 1

After what has been said you will appreciate, if never before, why mother's milk cannot be replaced by that of the cow — least of all by proprietary foods of unsatisfactory or irrational composition. Our imitations are poor indeed, and "the steam sterilizer will never replace a mother's love and attention." Nevertheless, when necessity or preference calls for some substitute for mother's milk, the attempt must be made to approach as nearly as possible to the natural diet of the infant. A glance at the comparative analyses will indicate why attention has been directed in recent years to the use of mare's and ass's milk. In digestibility and composi-

tion they seem to resemble mother's milk somewhat more closely than does cow's milk; while goat's milk, contrary to the current belief, is rather closely allied to that of the cow.

In addition to these details of composition pertaining to the use of foreign milk, there is the further fact that children are accustomed to get food far more easily from the bottle than from the breast, and too often they become the recipient of an undue quantity of the artificial food through the misguided generosity of the sympathetic mother or nurse. The actual capacity of the infantile stomach at various periods is

surprisingly small when expressed in absolute figures. According to Rubner it ranges as follows:

First week	46 cc.	(1½ ounces)
Second week	72 cc.	(2⅖ ounces)
Second month	140 cc.	(4⅔ ounces)
Twelfth month	400 cc.	(13⅓ ounces)

The problem of infant nutrition is, perhaps, the most serious one connected with the physiology of childhood, and it involves primarily the proper adjustment of the food in quality and quantity to the digestive capacity of the young. "If on the one hand we observe how carefully nature has adapted the composition of the milk to the needs of every species of mammal, and if on the other we consider how ignorant we

are concerning the nature of the food-stuffs, the digestive processes in the infant and the disturbances which these are liable to from the myriad micro-organisms in the intestines, it is not a matter for wonder that in spite of the gravest efforts the natural diet for infants has not yet been successfully replaced by any artificial food." . . . The census taken in Berlin in 1890 showed that there were then 39,000 children under the age of one year in that city. Of these 20,000 were breast-fed, 16,000 were reared by hand. Of the breast-fed children one in thirteen died, whereas among those brought up by hand the mortality rose to one out

of every two infants. . . . "No doubt this exceessively high rate of infant mortality is due not only to the unnatural mode of diet, but partly to the neglect which is doubtless in many cases associated therewith; since a mother who nurses her child would also, as a general rule, instinctively lavish more care upon it." —[Bunge] We have lived to see considerable progress made in recent years in the artificial nutrition of the young, and the introduction of accurate "percentage feeding" by Professor Rotch marks a distinct advance over the older methods of guesswork and trial. To-day the progressive physician, co-operating

with the intelligent mother, is in a position to ascertain whether the various nutrients fed are satisfactorily utilized, and to readjust the composition of the food mixture to meet the requirements of the individual case. If the fats or the proteids are incompletely digested, the proportion of either can be modified without any extensive change in the remaining constituents. We are thus attempting precisely what nature accomplishes by varying the composition of the milk at different intervals during the period of lactation. The composition of the milk changes in accordance with the rate of growth; just as the suckling grows most vig-

orously soon after birth and increases in weight less rapidly as time goes on, so the amount of proteid and mineral ingredients in the milk also diminishes with the duration of lactation.

The most progressive clinicians agree in attributing no small share of the digestive disturbances of infancy to overfeeding. If we bear in mind the more tardy digestibility of cow's milk, and the attendant danger of a decomposition of the unabsorbed residues, with a consequent distribution of poisonous products in the organism, the train of difficulties which attend indiscretions in feeding is apparent. The possibility of under-

feeding is usually overfeared. It is infinitely better to lose a pound or two already gained than to endanger the entire organism with food which cannot be assimilated. An ounce retained is worth a pound regurgitated.

It has often seemed to me that many parents display an excessive zeal in foisting improper diets upon their children. They fail to realize the comparative limitations of the youthful digestive tract, while the children too soon learn to imitate the customs of their elders. This is true, for example, in the habit of eating meat, a stimulating and concentrated proteid food. "The colt or calf does not thrive on a diet of

rich corn meal, though it may be very proper for the horse or cow. Carnivorous animals, be it noted, do not allow their young to have meat until quite a time after they have all their teeth fully developed, though apparently it would be their proper food. Meat given to kittens or puppies invariably produces convulsions."[1] It is said that cats will take away meat from their kittens when it is given to them, even up to the time when they are three months old. In early infancy there is only imperfect provision for the digestion of starch; yet I could name

[1] Hoy: "Eating and Drinking," p. 252.

familiar so-called substitutes for mother's milk which abound in this foodstuff.

The intestine of the young is extremely delicate and far more liable to bacterial invasion than is the case in later life. This explains in part the easy susceptibility of children to intestinal infections; they succumb under conditions in which the adult is thoroughly immune. Hence has arisen the desire to protect the alimentary tract against the introduction of undesirable organisms. There are unfortunately two erroneous impressions regarding the efficacy of the sterilization or pasteurization of food,

which are not yet completely eradicated. The one assumes that the food, once sterile, will remain so, and disregards the danger of a subsequent exposure. The other, more serious mistake lies in the belief that in destroying germs the products of their previous activity are likewise eliminated. Milk once contaminated for any length of time can never be rendered wholesome by ever so thorough sterilization. The bacterial poisons are there to stay; accordingly, the precious food should be guarded against deterioration from the very beginning. Clean, fresh, carefully kept milk is a desideratum;

sterilization is at best a necessary evil: worst of all is the introduction of the so-called harmless preservatives which place a premium upon dirt by rendering cleanliness unnecessary instead of unavoidable.

I have already referred to the peculiar importance of the mineral nutrients for the proper development of the body, in illustration of which the familiar need of lime for the growth of the bones was mentioned. The figures, arranged in the table according to the ratio of lime contained, indicate how unlike is the distribution of mineral ingredients in different common foods.

ANALYSES OF MINERAL INGREDIENTS OF VARIOUS ARTICLES OF DIET

Arranged according to the ratio of LIME *contained*

	POTASSIUM K_2O	SODIUM Na_2O	LIME CaO	MAGNESIUM MgO	IRON Fe_2O_3	PHOSPHORUS P_2O_5	CHLORINE Cl
Beef	1.66	0.32	0.029	0.152	0.02	1.83	0.28
Wheat . . .	0.62	0.06	0.065	0.24	0.026	0.94	(?)
Potato . . .	2.28	0.11	0.1	0.19	0.042	0.64	0.13
Egg albumin	1.44	1.45	0.13	0.13	0.026	0.2	1.32
Peas	1.13	0.03	0.137	0.22	0.024	0.99	(?)
Human milk	0.58	0.17	0.243	0.05	0.003	0.35	0.32
Yolk of egg	0.27	0.17	0.38	0.06	0.04	1.9	0.35
Cow's milk .	1.67	1.05	1.51	0.20	0.003	1.86	1.6

Notice that a child would probably not obtain the lime requisite for the growth of its frame if brought up upon meat and wheat bread alone. Professor Bunge has lately called

attention to the possible danger to children in the increased consumption of candy, prepared as it is from pure sugar. He explains the popular notion regarding a connection between defective teeth and candy eating on the assumption that children who live largely on meat, bread, and candy — all poor in lime — may fail to get their proper quota of this element. He urges a return to lime-containing sweet fruits for the dietary of children. This seems to me more rational, at least, than the indiscriminate administration of lime-water. The quantities of lime in common foods are given in the table following:

QUANTITIES OF LIME IN FOODS

(Milligrams per 100 grams of the dry substance)

Sugar	0.0	Egg white	130.0
Honey	6.7	Peas	137.0
Beef	29.0	Plums	166.0
Wheat bread	46.0	Human milk	243.0
Grapes (Malaga)	60.0	Egg-yolk	380.0
Graham bread	77.0	Figs	400.0
Pears	95.0	Strawberries	483.0
Potatoes	100.0	Cow's milk	1510.0
Dates	108.0		

We frequently hear the remark that childhood is the period at which correct habits should be formed. The subject is one which perhaps more properly belongs to the psychology of youth; but the foundation of proper habits of rest, exercise, and diet should be based upon sound physiological grounds. Life is in

a sense a rhythm of inherited or acquired habits. With respect to one of these I cannot refrain from quoting Dr. Nathan Oppenheim. He says:

> "From the earliest possible time the habit of eating slowly and chewing the food very thoroughly must be insisted upon. If this is begun at an early enough age, it is easily learned and will prove to be a valuable acquisition for later years. If the child eats with an attendant or with the rest of the family, he should be allowed to talk to a reasonable extent; speech should be regulated, not forbidden. For with children, as well as adults, the act of speaking causes useful

breaks in the steady course of masticating and swallowing food; it allows the gastric contents to be well mixed with the secretions of the stomach, and at the same time it provides an atmosphere of reasonable enjoyment that a child may claim as well as his elders. The rule that children should be seen and not heard is capable of too strict an interpretation that lends itself very readily to petty domestic tyranny. So long as there is a reasonable and healthy discipline in the household, every child should be allowed to talk, to take part in the family life, to feel that he is an integral part of the home circle, and to realize that his words — even if they be not heavy with wisdom — will receive the

> consideration and attention which abiding love and a mild toleration dictate. The ordinary child whose environment provides suitable examples of self-restraint and good manners learns in a surprisingly short time how to conduct himself within sufficient bounds to be reckoned as a human being, and not as a more or less untamed animal."

I have dwelt upon the subject of table-habits because physiologists are just beginning to understand the real significance of the pleasure of the table in the functions of digestion, as well as in the broader enjoyment of life. The psychical element in digestion cannot be overrated. Fear, sor-

row, anguish, nausea, may promptly check the flow of the digestive juices; while palate-tempting dishes and the pleasure of the meal, with a congenial environment, are mighty incentives to the production of active digestive secretions. A scolding mother and a sensitive child make an unhealthy dining-room combination.

Dr. Elizabeth Campbell says:

> "Very rarely we find a mother or nurse too liberal, not tempering theory with sound judgment. It is then we realize that for the accomplishment of such a training a mother with a fine instinct, tempered by desire of investigation, and endowed with common sense in the appreciation of theory, is

not only the physician's ally, but a teacher from whom can be learned many precious truths."

However, "many a conscientious mother sighs on Sunday morning when she realizes that on that day the structure of habit she has so carefully reared during the week will be ruthlessly overthrown if it happens to please the father."

The guidance of the young in their bodily exercise and sports calls for no specific rules in contrast with those of the old, unless it be to modify the *extent* of their exertions. In the formative and impressionable period of their careers attention should be devoted more often than it is to the

elimination of physical defects. They are, frequently, remediable by the development of muscular power through the exercise of specific parts, and by inducing appropriate growth in plastic tissues. I have been impressed with the possibilities in this direction in my contact with young college students. Not only do our modes of dress for children lead to the malformation of parts of the body like the feet, but the current fashions in child play seem to me to cultivate the exercise of the arms and legs too exclusively. Weakness in the abdominal muscles is an undesirable defect. The juvenile overalls — dirt-proof and comfortable — are

therefore to be welcomed if they effect a transformation of the modern soldier-like play of children into the free-and-easy sport of animals. We must not relegate tumbling and rolling and climbing and jumping to the lost arts.

* * * * *

"Behold the child among his new-born blisses,
A six years' darling of a pigmy size!
See where 'mid work of his own hands he lies,
Fretted by sallies of his mother's kisses,
With light upon him from his father's eyes.
See at his feet some little plan or chart,
Some fragment from his dream of human life,
Shaped by himself with newly learned art, —
A wedding or a festival,
A mourning or a funeral;
And this hath now his heart,
And unto this he frames his song.
Then will he fit his tongue

To dialogues of business, love, or strife ;
But it will not be long
Ere this be thrown aside,
And with new joy and pride
The little actor cons another part,
Filling from time to time his ' humorous stage
With all the persons, down to palsied age,
That life brings with her in her equipage,
As if his whole vocation
Were endless imitation."

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